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Chapter 19

Nonferrous-Metal Products

THE nonferrous-metal products group includes industries producing nonferrous metals from the ore or recovering them from scrap; refining or alloying these metals; and producing commodities for which the metals or their alloys constitute the principal material. Large quantities of nonferrous metals and alloys are used in industries classified in other groups, particularly iron and steel products, chemicals, machinery, and transportation equipment. Establishments engaged in the primary production of aluminum are classified in the chemicals industry and not in the nonferrous-metals group.

In 1937 the value added by the nonferrous-metals group was about one third as great as that added by the iron and steel products group.

TRENDS IN THE PHYSICAL OUTPUT OF THE NONFERROUS-METAL PRODUCTS INDUSTRIES

Data on the output of the three basic smelting and refining nonferrous-metals industries—copper, lead and zinc—are available for the entire period 1899–1937 (Table 56 and Chart 21).[1] For the important industry in the next stage of production, "nonferrous-metal products, not elsewhere classified," and two minor industries, the data begin only in 1925, and for clocks and watches in 1927. Data on a number of important industries in the group are entirely lacking.

[1] The indexes for the three smelting and refining industries are unadjusted for changes in the coverage of the underlying samples. Excessive duplication in the output of these industries made it impossible to calculate a reasonably accurate adjustment. See Appendices A and B.

Physical Output: Indexes and Percentage Changes[b]

	Copper	Lead	Zinc	Secondary Metals, Nonprecious	Collapsible Tubes	Nonferrous-Metal Products, n.e.c.[c]	Clocks, Watches and Materials	Total	
								Unadjusted	Adjusted
YEAR	INDEX OF PHYSICAL OUTPUT (1929:100)								
1899	22	38	21	..	..	..	..	..	..
1904	31	51	30	..	..	..	..	..	..
1909	47	63	41	..	..	..	..	..	..
1914	52	72	57	..	..	..	..	..	..
1919	60	63	74	..	..	..	..	..	..
1921	34	60	34	..	..	..	..	..	..
1923	69	83	82	..	..	..	..	..	..
1925	78	99	90	78	94	70	..	76	79
1927	82	101	94	84	103	72	113	82	84
1929	100	100	100	100	100	100	100	100	100
1931	54	58	48	58	102	59	64	58	64
1933	30	36	50	67	108	43	48	43	47
1935	48	43	64	87	110	62	78	62	66
1937	80	58	86	124	124	88	139	92	89
PERIOD	NET PERCENTAGE CHANGE IN PHYSICAL OUTPUT								
1899–1937	+272	+51	+318	..	..	..	..	..	..
1899–1909	+117	+64	+98	..	..	..	..	..	..
1909–1919	+28	0	+82	..	..	..	..	..	..
1919–1929	+67	+59	+35	..	..	..	..	..	..
1929–1937	−20	−42	−14	+24	+24	−12	+39	−8	−11

[a] Industries for which there are no adequate quantity data for any period listed above are: secondary metals, precious; aluminum manufactures; tin and other foils; electroplating; fire extinguishers; gold leaf and foil; lighting equipment; needles and pins; plated ware; silverware; sheet metal work, not elsewhere classified; stamped and enameled ware; watchcases; and jewelry and jewelers' findings. These industries are covered by the adjusted total.

[b] The indexes have been constructed from basic data in the U.S. Census of Manufactures and reports of the U.S. Bureau of Mines, by methods described briefly in Chapter 2 and in detail in Appendix A. Appendix B presents these data, together with the indexes derived from them. The indexes cited here for individual industries have been adjusted to take account of changes in the coverage of the respective samples, except when such adjustment was impossible.

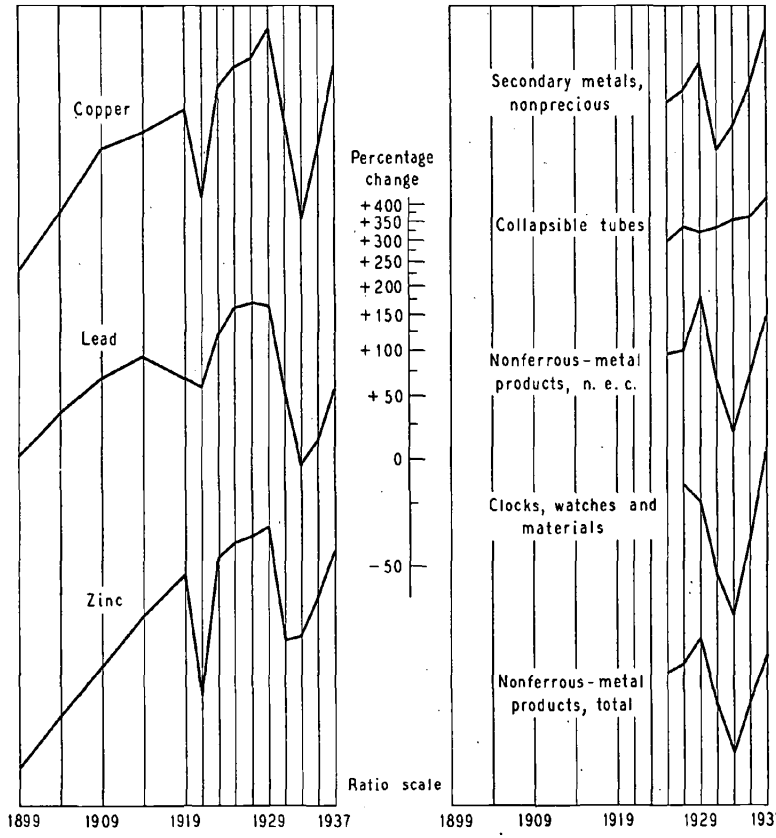
The percentage changes are not always entirely consistent with the indexes given above because the changes were computed from the indexes in Appendix B, which are carried to one decimal place.

[c] N.e.c. denotes not elsewhere classified.

Chart 21

NONFERROUS-METAL PRODUCTS

Indexes of Physical Output



Copper. This smelting and refining industry came close to quadrupling its output between 1899 and 1937. Most of the rise occurred in the decade 1899–1909, when production more than doubled; in the next decade the net gain was less than one third; from 1919 to 1929 it amounted to two thirds, but in the final period it declined as much as one fifth.

By-products like gold and silver increased at a rate somewhat slower than that which characterized copper produc-

tion. One reason for the disparity may be the inclusion, in the industry's copper output, of some secondary copper refined from scrap (which yields neither gold nor silver); copper from this source was increasing more rapidly than the primary metal derived directly from ore. There were changes also in the grade of ore smelted, and these too may help to account for the divergent trends in the output of copper and by-products. The downward trend in the grade of copper ore was significant on still another count, for reduction in the metal content of the ore mined involved an increase in the amount of effort required to produce a given quantity of metal. On the other hand, advances in metallurgical processes gave rise to enhanced efficiency in the extraction of the metal present in the ore. These and related improvements have offset the decline in grade only in part, however, as is shown by estimates of the copper yield per ton of ore, which reflect the net result of declines in grade and increases in efficiency of extraction.[2] In 1889 each ton of ore yielded over

[2] No general figures are available for a measurement of the individual force of each of these influences. The following figures relate to three mills:

	Utah Copper Mill		*Ray Mill (Hayden)*		*Miami Mill*	
	1911	1930	1911	1930	1911	1930
	(pounds of copper per ton of ore)					
Yield	21	17	23	17	37	12
Metal content	30	19	36	20	50	15
Unextracted metal	9	2	13	3	13	3

In the Utah Mill, for example, the yield per ton declined from 21 lbs. in 1911 to 17 lbs. in 1930. Total metal content fell from 30 lbs. to about 19. Unextracted metal, therefore, was nine lbs. in 1910 and two lbs. in 1930. The decline of 11 lbs. in metal content, which measures the deterioration in the quality of the ore, was largely but not entirely counterbalanced by a rise of seven lbs. in metal extracted, which measures the increased efficiency of extraction. See A. V. Corry and O. E. Kiessling, *Grade of Ore,* Report No. E–6 (National Research Project in cooperation with the Bureau of Mines, Aug. 1938), p. 52. The data are cited from T. O. Chapman, Bureau of Mines *Bulletin No. 392,* pp. 10–11, and A. B. Parsons, *The Porphyry Coppers,* p. 200. A large fraction of the increased efficiency of extraction should probably be credited to copper concentrators, which are not treated by the Census as manufacturing establishments.

65 pounds of copper. The yield per ton dropped to about 53 pounds in 1902, 40 pounds in 1909, 33 pounds in 1919 and 28 pounds in 1929. During the recession following 1929 the yield rose, as a result of a deliberate avoidance of the leaner ores, reaching a level of about 42 pounds per ton in 1933.[3]

Lead increased in output at a very much lower rate than copper. The rise from 1899 to 1937 was only 51 percent, the net result of large gains in the first and third decades, a minute decline in the second decade, and a drastic one in the last period. The peak output came in 1927. The drop from that point brought output in 1937 to a very low level.

As in the copper industry, gold and silver by-products declined in relation to the output of the primary product, lead. Although lead production rose much less rapidly, between 1899 and 1937, than did copper output, the percentage decline in yield per ton of ore treated was about as great: in 1910 the number of pounds of lead obtained from a ton of ore averaged 110, and in 1930 the corresponding yield was 85 pounds.[4]

Zinc. In this industry output rose more rapidly than it did in the other two smelting and refining industries. From 1899 to 1937 the net gain amounted to 318 percent. In the first decade production doubled; from 1909 to 1919 it rose at a rate only slightly lower; and from 1919 to 1929 it increased by about a third. From 1929 to 1937 output fell almost one seventh.

Here too, gold by-products declined in relation to the main product; however, silver changed irregularly, with a net relative rise. The downward trend in the grade of zinc ore was offset in part by shifts to higher-tenor ore deposits. These, together with improvements in metallurgy, served to prevent a serious drop in the average yield per ton of ore. Yields in the Joplin region, the largest source of domestic production,

[3] Corry and Kiessling, *op cit.*, p. 2.
[4] *Op. cit.*, p. 71.

actually rose from 1910 to 1930. In the Eastern and Western regions, however, there were definite reductions in yield.[5]

The declines in the grade of the nonferrous ores treated in the smelting and refining industries, and the increases in the percentage of metal extracted in smelting and refining operations, suggest that the net physical output of these industries advanced more rapidly than their gross physical output. The extraction of 30 pounds of copper metal from two tons of a given grade of ore represents a greater *net* contribution to the national output than does the extraction of 30 pounds of metal from one ton of an ore of much higher tenor. Again, a yield of 20 pounds of copper metal from a single ton of a given grade of ore represents a greater net contribution than 20 pounds of copper metal extracted from two tons of the same grade of ore. Since the cost of materials in the smelting and refining industries constitutes a very large fraction of the value of products, even slight savings in materials must have meant large increases in the net output in relation to the gross output. Unfortunately, data adequate enough for a reasonably accurate computation of net output are not available.[6]

Secondary Metals, Nonprecious. This classification includes establishments engaged *primarily* in the recovery from scrap and dross of copper, lead, zinc, nickel and their alloys. As we have noted, a certain amount of secondary metals is produced by refineries engaged principally in the refining of metals from newly smelted ores. The output of the secondary

[5] *Op. cit.*, pp. 72, 75.

[6] If there were a rise in the percentage of copper extracted, say, from 80 percent in 1910 to 95 in 1930 (compare the Calumet and Hecla figures cited by Corry and Kiessling, *op. cit.*, p. 10), and if the cost of materials constituted 90 percent of the 1910 value of copper (see the 1909 Census), then the index of net output (1930 on the 1910 base) would be two and a half times as great as the index of gross output. However, as stated in footnote 2 above, the rise in the percentage of copper extracted is in part due to improvements in concentration processes that are performed before the ore reaches the smelter. Therefore the index of net output could not have risen as rapidly, relatively to the index of gross output, as this computation would suggest.

metals industry rose 28 percent from 1925 to 1929, and 24 percent from 1929 to 1937, a net gain of 59 percent. This trend contrasts with the movement of the output of the primary refineries.

Nonferrous-Metal Products, not elsewhere classified, the most important industry in the group, comprises establishments manufacturing nonferrous alloys and products made from nonferrous alloys and metals (except aluminum). Many important products made from nonferrous metals and alloys are classified elsewhere: in wire, wire products, electrical machinery, structural metal work, hardware, and screw-machine products. The output of the present industry rose 43 percent from 1925 to 1929, and fell 12 percent from 1929 to 1937. The net gain between 1925 and 1937 was 26 percent. Of the more important products of the industry for which we have data, those whose output rose between 1925 and 1937 were copper sheets and plates, brass and bronze rods, copper rods, and brass and bronze tubing, and those with seriously declining output were lead tubing, antifriction-bearing metal, and brass and bronze rough castings.

Clocks, Watches and Related Materials fell 12 percent from 1927 to 1929, but made a net gain of 39 percent from 1929 to 1937. There were notable rises, over the entire decade, in the output of electric clocks, which increased from 87,000 to 4,269,000. Clock movements for use in recording instruments and gauges, time stamps, time switches, and time locks, rose from 239,000 in 1929 to 1,131,000 in 1937. The final products, time stamps, time switches, etc., increased from 129,000 in 1929 to 429,000 in 1937.[7] There were only moderate gains in the output of ordinary alarm clocks and nonjeweled watches.

Summary. Two of the three nonferrous smelting and refining industries increased their output between 1899 and

[7] The duplication of clock movements does not affect our index in any serious degree.

1937 less rapidly than all manufacturing industries combined. The output of one of these, lead, lagged even behind population growth. In the period 1929–37, three out of seven industries increased their output.

For the nonferrous-metal products group as a whole we have an index of physical output only for the period beginning in 1925. The low coverage for earlier years precludes the calculation of an adequate index for those years.[8] According to the unadjusted index, the group's output rose 32 percent in 1925–29, and fell 8 percent in 1929–37, a net gain of 21 percent. The adjusted index shows that output increased somewhat less rapidly between 1925 and 1929, fell more sharply between 1929 and 1937, and made a smaller net gain (13 percent) between 1925 and 1937.

CHANGES IN THE INDUSTRIAL PATTERN OF NONFERROUS METAL MANUFACTURE

The zinc industry rose in relation to copper, and copper rose in relation to lead, during the period 1899–1937 considered as a whole. In 1929–37 zinc, secondary metals, collapsible tubes, and clocks and watches, increased their relative contributions to the group's output, while copper, lead, and nonferrous-metal products (not elsewhere classified) lost ground.

These changes in the pattern of the group's output are examined from another point of view in Table 57, in which we present the relative contributions, in percentage form, for

[8] We decided not to accept the combined index of output of the three smelting and refining industries—copper, lead and zinc—as representative of the group. The dangers inherent in such a procedure are revealed by the figures for the recent period: our group index, based on fairly adequate coverage, fell only 8 or 10 percent from 1929 to 1937. The combined index for copper, lead and zinc fell over 20 percent between these two years.

An index for the group based on nonferrous-metal consumption is unacceptable also because a large (and perhaps variable) fraction of these metals is consumed in the iron and steel, chemicals, machinery and transportation-equipment groups.

TABLE 57

NONFERROUS-METAL PRODUCTS

Relative Contributions of Component Industries to the Physical Output of the Entire Group[a]

Industry	*Percentage Distribution, Comparable Pairs of Years*					
	1925	1937	1925	1929	1929	1937
Copper	8.8	8.4	8.4	8.5	7.2	6.4
Lead	3.4	1.8	3.1	2.5	2.7	1.8
Zinc	4.3	3.8	4.2	3.7	3.9	4.0
Secondary metals, nonprecious	1.4	2.0	1.7	1.7	1.7	2.3
Collapsible tubes	0.4	0.5	0.4	0.3	0.3	0.4
Nonferrous-metal products, n.e.c.[c]	22.7	26.4	23.0	25.8	27.6	27.2
Clocks, watches and materials	59.0	57.1	59.2	57.4	4.4	6.8
All other products					52.3	51.2
TOTAL[b]	100.0	100.0	100.0	100.0	100.0	100.0

[a] Derived from Table 56. For an explanation of the derivation of the measurements see footnote 10, Chapter 4.

[b] The columns do not add up to 100.0 in every instance because they contain rounded percentages.

[c] N.e.c. denotes not elsewhere classified.

selected years. Here we note that between 1925 and 1937 there was a substantial decline in the relative contribution of the lead industry, from 3.4 to 1.8 percent. Copper and zinc declined less markedly. The contribution of nonferrous-metal products (not elsewhere classified) increased from 22.7 percent to 26.3, but the remaining industries in the group declined in this respect.

The data on relative contributions to the physical output of the group are available for a very limited period, and for only a few industries. Some information on the industrial pattern of output of the group in other years, and covering a broader representation of industries, is provided by the data on value added. These are presented in Table 58.

The relative contributions to the group's value added of two of the three smelting and refining industries fell drasti-

TABLE 58

NONFERROUS-METAL PRODUCTS

Relative Contributions of Component Industries to the Value Added by the Entire Group[a]

Industry	*Percentage Distribution*						
	1899	1909		1919		1929	1937
		Comparable with		Comparable with later years			
		1899	1919	1909			
Copper	19.4	12.9	13.8	8.8	8.6	6.6	6.9
Lead	14.1	4.4	4.7	2.3	2.2	2.5	1.9
Zinc	2.2	2.6	2.7	4.5	4.4	3.9	4.0
Secondary metals, nonprecious	0.9	1.4	1.5	1.9	1.9	2.0	1.9
Secondary metals, precious	0.4	0.5	0.5	0.8	0.7	0.6	0.7
Aluminum manufactures				[b]	3.3	5.2	6.9
Collapsible tubes	0.2	0.3	0.3	0.6	0.6	0.3	0.4
Tin and other foils						0.6	0.6
Electroplating	0.9	0.9	1.0	1.0	1.0	1.7	2.0
Fire extinguishers	0.1	0.1	0.1	0.4	0.4	0.4	0.5
Gold leaf and foil	0.5	0.3	0.3	0.2	0.2	0.2	0.1
Lighting equipment	5.4	7.0	7.5	5.5	5.3	7.7	6.0
Needles and pins	0.9	1.3	1.3	2.5	2.4	1.4	2.6
Nonferrous-metal products, n.e.c.[c]	13.7	16.1	17.2	25.4	24.6	27.4	27.6
Plated ware	3.0	2.9	3.1	3.2	3.1	3.4	3.4
Silverware	3.5	3.9	4.1	2.1	2.1	1.8	
Sheet metal work, n.e.c.[c]	12.8	18.6	12.9	10.5	9.9	9.7	7.3
Stamped and enameled ware	5.4	7.7	8.2	10.6	10.3	10.3	14.6
Clocks	1.8	2.4	2.6	2.1	2.1	2.8	5.9
Watch and clock materials	0.1	0.1	0.2	0.1	0.1	0.1	
Watches	2.5	2.7	2.9	3.4	3.3	2.1	
Watch cases	1.5	1.6	1.7	1.5	1.5	0.8	0.6
Jewelry	10.8	12.4	13.3	12.4	11.9	8.6	5.3
Jewelers' findings							0.7
TOTAL[d]	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Basic data are given in Appendix C.
[b] Included in various other industries.
[c] N.e.c. denotes not elsewhere classified.
[d] The columns do not add up to 100.0 in every instance because they contain rounded percentages.

cally between 1899 and 1937. The contribution of copper declined from 19 percent in 1899 to about 13 in 1909, to 9 in 1919, and finally to 7 in both 1929 and 1937. Lead fell from

14 percent in 1899 to 4 in 1909, then to 2 in 1919–37. The contribution of zinc rose from 2 to 4 percent. The three industries combined accounted for 36 percent of the group's value added in 1899 but for only 13 in 1937. Large relative declines are found also in the contributions of silverware, sheet-metal work, and jewelry (including findings), industries for which we have no data on physical output.

The most important rise occurred in the relative contribution of nonferrous-metal products (not elsewhere classified). In 1899 this industry accounted for 14 percent of the group's value added; the percentage rose steadily until by 1937 it had reached 28, an increase of 14 points. Stamped and enameled ware increased its contribution from 5 percent in 1899 to 15 in 1937. There were other, but less important, rises in the contributions of nonprecious secondary metals, aluminum manufactures, electroplating, needles and pins, and clocks.

It is difficult to determine whether the decline in the combined value contribution of the industries engaged in the smelting and refining of the primary nonferrous metals and the rise in the value contribution of the other industries during the period 1899–1937, reflect closely corresponding changes in the group's pattern of physical output. A fair correspondence is indicated by the data available since 1925. If a similar correspondence prevailed also during the period preceding 1925, as seems likely, we must conclude on the basis of the value added data that the output of the entire nonferrous-metal products group rose considerably more than the 225 percent recorded for the combined output of the three smelting and refining industries in the period 1899–1937.

To some extent the relative decline in smelting and refining was due to an increase in the production of secondary metals (not refined in primary plants) at the expense of both primary and secondary metals passing through the three

smelting and refining industries. The following figures, not available for the earlier years, indicate such a trend:

	1919	*1929*	*1937*
Copper (million pounds)			
1. Production at primary refineries	1,841	3,074	2,447
2. Secondary production, not at primary refineries	503	919	751
3. Ratio, 2 ÷ 1	.27	.30	.31
Lead (thousand short tons)			
1. Production at primary refineries	495	840	497
2. Secondary production, not at primary refineries	110	246	279
3. Ratio, 2 ÷ 1	.22	.29	.56
Zinc (thousand short tons)			
1. Production at primary refineries	477	637	581
2. Secondary production, not at primary refineries	29	54	58
3. Ratio, 2 ÷ 1	.06	.08	.10

In every case we find an increase in secondary production relative to primary refinery output of new and recovered metal.

A second important factor making for a drop in the output of the smelting and refining industries in relation to the output of the industries engaged in the further fabrication of nonferrous-metal products was the comparative decline in the volume of exports of domestically-produced refined nonferrous metals:

	1909	*1919*	*1929*	*1937*
Copper (million pounds)				
1. Total production	1,480	2,345	3,993	3,198
2. Exports minus imports	622	403	770	605
3. Ratio, 2 ÷ 1	.42	.17	.19	.19
Lead (thousand short tons)				
1. Total production	488	604	1,085	776
2. Exports minus imports	82	46	72	15
3. Ratio, 2 ÷ 1	.17	.08	.07	.02
Zinc (thousand short tons)				
1. Total production	289	505	690	639
2. Exports minus imports	−7	122	14	−37
3. Ratio, 2 ÷ 1	−.02	.24	.02	−.06

The data on secondary (hence on total) production are not available for 1899, but it is probable that larger fractions of each of the metals were exported in 1899 than in 1909.

Other factors may be involved in the change in the pattern of output of the nonferrous group, for example an increase in the percentage of available nonferrous metals utilized in further fabrication in the nonferrous group itself; or an increase in the degree of fabrication of given quantities of nonferrous metals. These factors it is impossible to appraise, since no measures of the increases can be obtained.